

PHYSICAL AND BEHAVIORAL DEVELOPMENT OF A ROADRUNNER RAISED AT THE NATIONAL ZOOLOGICAL PARK

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ON 15 December 1967, the National Zoological Park in Washington, D. C., received a pair of Roadrunners (*Geococcyx californianus*) that had previously raised young in captivity at Duke University, Durham, North Carolina (Calder, 1967).

Upon completion of quarantine procedures, the pair of Roadrunners was housed in an outdoor aviary, 10 × 15 × 8 feet high. One end was provided with a shelter 5 × 3 × 4 feet high, which was heated in cold weather by means of a 250-watt infrared heat lamp. The floor of the aviary and shelter was covered with a 6-inch layer of sand, which was used on many occasions by the birds to take "dust baths." They also were extremely fond of lying in the sun whenever possible. The top 3 feet of the aviary was covered in the colder months with a layer of transparent plastic to keep out rain and snow.

A pair of Green Hunting Cissas (*Cissa chinensis*), a species of corvid indigenous to south Asia, was also housed in the aviary, and as these are arboreal birds and the Roadrunners are primarily terrestrial, there proved to be little competition between the species for space.

The daily diet for the Roadrunners consists of pre-killed white mice and ground horsemeat, enforced with Pervinal (a powdered vitamin supplement manufactured by the U. S. Vitamin and Pharmaceutical Corporation). In addition, an occasional live English sparrow manages to enter the aviary through the wire mesh and is killed and eaten by the Roadrunners.

Early in the spring of 1968 the pair of Roadrunners began the typical breeding behavior of the species. This subject has been described at length by several authors so it will not be dealt with here. (Rand, 1941) (Calder, 1967) (Bent, 1940).

To encourage breeding efforts by the pair, nesting material in the form of twigs and pine needles was provided, as well as a breeding platform on the ground within the shelter 12 inches square and 18 inches high. These facilities were acceptable to the pair and they soon had a substantial nest constructed. It was decided at this time to minimize interference and disturb the pair as little as possible. The female began spending extended periods of time on the nest in May and it was assumed she had begun incubation.

At this time, the cissas were noticed attempting to enter the shelter and some aggression was observed on the part of the male Roadrunner. We were well aware that corvids are practiced egg stealers; however, it was believed that the Roadrunners, being larger and more aggressive, could quite adequately protect their nest. Later circumstances proved this hypothesis to be erroneous, however, when one morning late in May the keeper observed the female out of the shelter in the aviary acting in a listless manner. Examination of the nest revealed the broken remains of one egg. The pair of cissas was removed from the aviary, but no further nesting activities were observed that spring.

In October, 1968, the infrared lamp in the shelter of the Roadrunners' aviary was turned on in anticipation of cold weather. The resultant increase in light rays served to stimulate the birds and they were again observed in courting and breeding activities. The female proved less enthusiastic than the male in this instance, and only desultory efforts were made in nest building.

On 22 November 1968, the keeper found a single egg deposited on the sand floor of the aviary, which he removed. The following day the male Roadrunner, unable to force the female to set in the normal manner, vented his frustration in the displacement activity of attacking the female. This resulted in severe scalp lacerations and she was removed for treatment and recuperation.

On the afternoon of 23 November the egg was placed in an electric forced-air incubator at a temperature of 99.5° F and a relative humidity of 83 per cent. The egg was turned manually three times daily, and on the morning of 12 December it hatched after an incubation period of 18½ days. (Descriptions of Roadrunner eggs can be found in Bent, 1940, pp. 40-41).

HATCHING DESCRIPTION

The young Roadrunner presented a very distinctive appearance when hatched. Its skin was a dull black and had a peculiar oily appearance. The eyes were closed and covered with black skin, as were the legs. The upper and lower mandibles were black and the mouth commissure was dull flesh pink. White nessoptiles were very noticeable against the black skin, and were present in the areas of the pterylae, the apteria being bare.

An interesting modification noticed in the young Roadrunner was that the spinal tract was divided laterally into two distinct tracts and an additional apterium was formed behind the capital tract along the spine. The marginal covert tracts on the wings were also set back further from the anterior edge of the wing than is normal for most bird species, and this condition was retained when the feathers emerged. (Perhaps this modification might have some advantage in increased air contact to the skin, therefore aiding heat dissipation in a warm climate).

The weight of the young Roadrunner at 24 hours was 19.92 g. It was strong and active upon hatching and as soon as it was dry, responded to touch by gaping.

GAPE DESCRIPTION

The interior of the young Roadrunner's mouth was as distinctive in appearance as his other physical aspects. The upper and lower mandibular tomia were black, as was the tip of the tongue. The rictus was flesh colored. The hard palate was white, and the remainder of the buccal cavity was a bright red, with the exception of four white directive markings. Two of these markings were located as stratum corneum on the tunica propria in the stratified epithelium of the two soft dorsal areas at the base of the grooved tongue. The remaining two white markings were located as conical processes originating from either the lamina propria or the submucosa of the palatal folds in the lateral wall of the oral pharynx. These were posteriorly located on the sides of the choanal slit above and to both sides of the two tongue markings. [Similar conical processes are found with more exaggeration in the semi-terrestrial Crested Coua (*Coua cristata*), a species of cuckoo indigenous to Madagascar (Welty, 1963). This may be an anatomical feature common to the young of other cuculids.] The dorsal surface at the base of the tongue and the posterior areas of the two palatal folds exhibited very noticeable white, posteriorly directed cornified papillae.

It is of interest to note that the areas containing the directive markings are those described in other species as also being most abundant in taste buds (Farner, 1960). It would be an interesting study to determine whether there is a correlation between the directive markings and taste buds in young Roadrunners.

Calder (1967) failed to rear artificially hatched Roadrunner chicks, although young were successfully raised in captivity when hatched and reared by the parents. It was his hypothesis that perhaps digestive enzymes were passed by the parent to the chick and were necessary for food digestion. Our experience disproved this hypothesis, as our young Roadrunner chick was raised to maturity without any digestive enzymes being added to the diet.

DIET, GROWTH AND BEHAVIORAL DEVELOPMENT

First Day.—The young Roadrunner was first fed 24 hours after hatching. The food consisted initially of the soft abdominal parts of grey crickets, the soft white grubs of stable flies; small, whole, freshly killed anolis lizards (*Anolis carolinensis*) with an average weight of 1.4 g, and small dieed pieces of freshly killed white mice. This varied diet was supplemented once daily with one drop of ViDaylin-M (a liquid vitamin-mineral supplement manufactured by the Ross Laboratories, Columbus, Ohio).

The young bird was fed 1.5–3.0 g of food hourly from 07:00 to 21:00. Further food



FIG. 1. Roadrunner, 4 days old. Dorsal view.

was usually refused after 21:00 and it was his custom to remain quiet throughout the remainder of the night. I noticed that the abdomen was quite elastic and had a great capacity for food storage and I believe that much of the food ingested during the day completed the digestive processes during the night hours.

The young bird was removed from the incubator when dry. He was housed in a cloth-lined shoe box and placed in an electric brooder set at 90° F. This temperature was later lowered at 7 days to 85° F and at 14 days to 75° F.

Third Day.—At 3 days the Roadrunner's weight had increased to 33.5 g. The sheathed tips of the primaries and rectrices began to emerge.

Fourth Day.—By four days the chick's weight had increased to 45.5 g. The primaries and rectrices had further developed and the tips of the secondaries had begun to emerge. The tips of the sheathed primaries emerged white in color; the secondaries were black.



FIG. 2. Roadrunner, 7 days old. Dorsal view.



FIG. 3. Roadrunner, 11 days old. Side view.

The four middle rectrices emerged completely black. The remaining outer rectrices showed white tips.

By this age the young bird's gaping movements could be visually induced by the extended hand, and there was some improvement of the muscular control of neck movements.

His eyes were first noticed open at 84 hours and were black in color.

Sixth Day.—The chick's weight at six days was 68.5 g. Emerging pinfeathers were visible on all pterylae. Faint white tips were discernible on the sheathed secondaries. The four middle rectrices emerged completely black. The remaining outer rectrices showed white tips.

and the tips of the two middle rectrices were free of the sheath.

The young bird had become much more alert and responded by gaping and wing fluttering to visual stimulation. He began uttering a very characteristic rasping note accompanied by a hissing sound. This was performed with the gape open.

At this age he was able to rise on the tarsometatarsus and exhibited a very strong grasping reflex when lifted. The neck and head movements were much more controlled; the head no longer jerked to the back and sides.

On the sixth day the length of time was increased between daytime feeding periods to two hours. Larger amounts of food were consumed at a feeding, including whole grey crickets and larger pieces of mice, as well as whole hairless mice. The chick could easily swallow articles of food weighing 3 g.

Eighth Day.—The weight of the chick at eight days was 93.7 g. He had become more active and could move about in his box. His legs and feet were growing very noticeably, and were larger in relationship to the body size than at a previous age.

Throughout the growing process the fecal matter was enclosed in a fecal sac. Most roughage was passed through the digestive system intact, including bones and chitinous material.

Eleventh Day.—By eleven days the chick was growing with amazing rapidity. His weight was 131.5 g. Most of his feather tips were clear of the sheaths and the feathers of the ventral pterylae were over 50 per cent clear of the sheaths, as were the marginal coverts. At eleven days the young Roadrunner could walk around on his feet, unsupported



FIG. 4. Roadrunner, 11 days old. Gape Markings.

by the tarsus. His legs and feet had grown remarkably large and had changed in color from black to grey, with the ventral portions of the feet and toes flesh color.

The young bird could no longer be confined to the shoe box and ran about in the $3 \times 2 \times 3$ foot high brooder. At this age the chick first showed signs of fear and an awareness of everything that occurred in his field of vision. As a result of these initial fear reactions, he often refused food when offered, and his weight gain showed a slight decline. This fear reaction stage was manifested for a period of three days, then regressed.

Fourteenth Day.—At 14 days the young bird weighed 153.7 g. All the feathers were clear of the sheaths excepting the primaries, secondaries and reetries which retained the proximal half of the sheaths. The natal hairs were still evident on the distal ends of most feathers. By this age the young bird displayed the full feather color patterns characteristic of the adults, and the red bare skin patch on the sides and rear of the head, characteristic of the species, was first noticed.

The chick had become very active and spent a lot of time running about. He still accepted his food from the keeper's hand and could now consume a whole, freshly killed white mouse. He was not noticed picking up food for himself at this time.

The chick was experimentally fed a small whole lake smelt. Apparently the taste was offensive, as he would not again voluntarily accept smelt when offered.

Sixteenth Day.—The weight of the young Roadrunner at 16 days was 174.0 g. He had begun exhibiting the bill clacking, tail bobbing, and crest raising behavior so characteristic of Roadrunners. When allowed the occasional freedom of the room, he was able to run very rapidly with a full leg stride. It was noticed he would now stretch his wings and he began some preening motions.

At 16 days he began picking up and swallowing food objects; however, he would still beg for food from passing people. He was moved to a wire cage $3 \times 3 \times 3$ feet high.

Twenty-fourth Day.—At 24 days the Roadrunner chick weighed 255.0 g. He habitually ate whole mice and bits of raw meat from a pan, and seldom begged for food from the

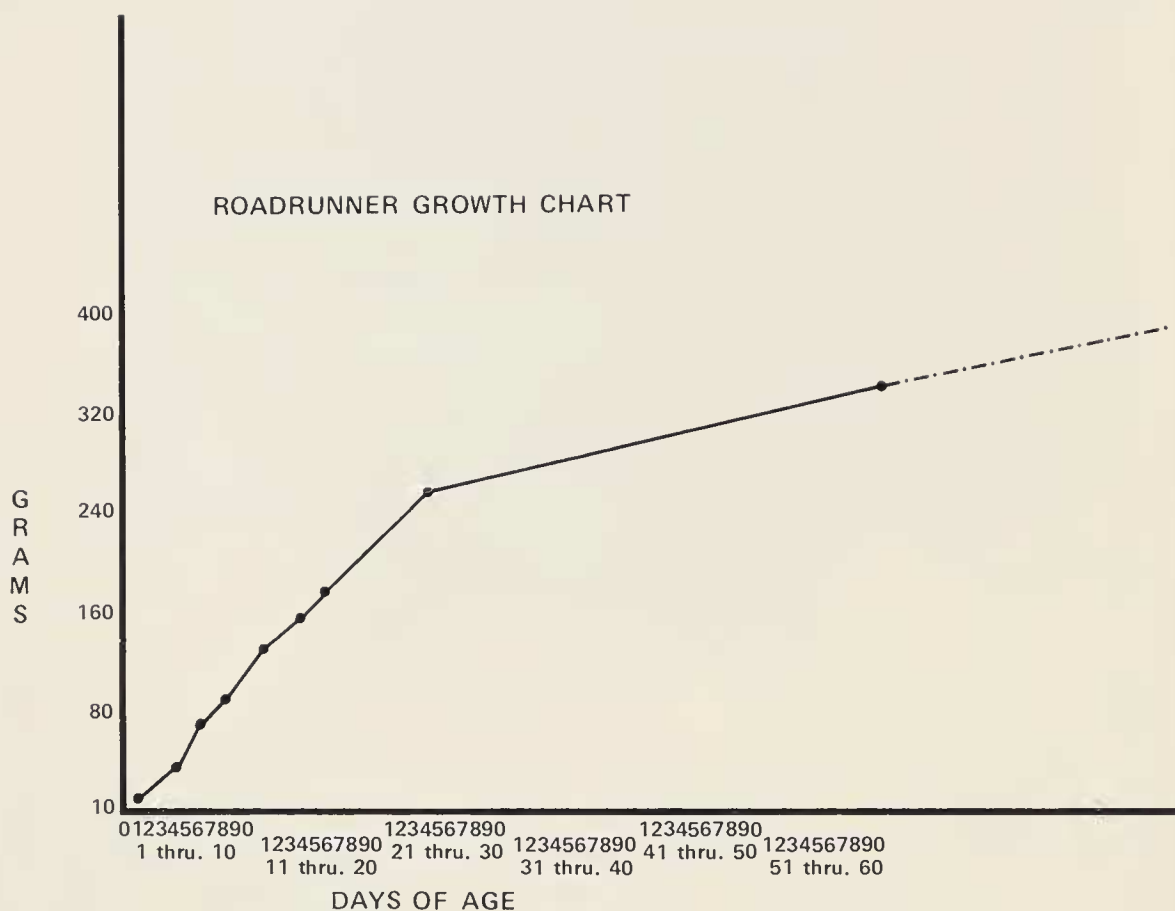


FIG. 5. Roadrunner Growth Chart.

keepers. In appearance the young Roadrunner look much like an adult, with the exceptions that he lacked feather sheen, was smaller in size, had dark eyes and had only three-quarter growth to the tail. All feather sheaths and natal hairs and been discarded.

The Roadrunner was moved to a 10 × 4 × 7 foot high aviary. He could now fly and habitually perched near the top of the aviary at night.

Sixtieth Day.—By 60 days the Roadrunner had achieved a near adult weight of 340.10 g. His iris had changed from black to light grey. In details of behavior, size and appearance he was indistinguishable from an adult. He had not moulted any of the juvenile plumage at this age. The young Roadrunner was moved to an outdoor aviary in April, and was able to kill and devour an intruding sparrow with expertise. This was apparently done instinctively as he had had no contact with other Roadrunners, or birds of any species.

It is of interest to note the very steady growth rate of this bird. This is evidenced by Figure 5, which illustrates a very moderate sigmoid curve.

SUMMARY

A young Roadrunner was hatched in an artificial incubator at the National Zoological Park, Washington, D. C., after an incubation period of 18½ days. Descriptions of size, appearance and mouth patterns are given.

Detailed descriptions are given of growth patterns, behavior manifestations and rearing techniques from the age of 24 hours to 60 days.

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NEW LIFE MEMBER

Eliot F. Porter of Santa Fe, New Mexico is a new Life Member of The Wilson Ornithological Society. A graduate of Harvard Medical School, Dr. Porter is currently a self-employed photographer and writer. Members of the Society are certainly familiar with his many excellent color photographs which have illustrated such things as "The Birds of Arizona," five of the Sierra Club Exhibit Format books, as well as many other books. Mr. Porter is a member of the AOU, Cooper Society, National Audubon Society, Wilderness Society, and a Director of The Sierra Club. He is married and has five sons.